Claims

What is claimed is:

1. A method for motion correcting MRI measurement data comprising the steps of:
a) receiving a plurality of sets of the MRI measurement data indicative of at least an image of an object, each set corresponding to one row k_x of a k-space matrix of at least a k-space matrix;
b) selecting for each set of the plurality of sets of the MRI measurements a k-space matrix of the at least a k-space matrix for allocation thereto;
c) determining for each set of the plurality of sets of the MRI measurement data a location within the k-space matrix allocated thereto; and,
d) generating at least a k-space matrix based on the sets of the plurality of sets of the MRI measurement data allocated thereto.

2. A method for motion correcting MRI measurement data as defined in claim 1 comprising the step of:
b1) determining the k-space matrix of the at least a k-space matrix for selection based on motion data indicative of the motion of the object occurring during acquisition of the plurality of sets of the MRI measurement data.

3. A method for motion correcting MRI measurement data as defined in claim 1 comprising the step of reconstructing at least an image by inverse Fourier transforming the at least a k-space matrix.

4. A method for motion correcting MRI measurement data as defined in claim 3 wherein the at least an image comprises a sequence of images.

5. A method for motion correcting MRI measurement data as defined in claim 2 wherein the motion is a periodic motion with a period of P_c seconds.

6. A method for motion correcting MRI measurement data as defined in claim 5 wherein step (b1) the k-space matrix is determined in accordance with $i = \mathrm{mod}(n-1, P_c f_s)+1$ with i indicating the k-space matrix, n indicating the set, and f_s being the sampling frequency of the MRI data acquisition process in Hz.

7. A method for motion correcting MRI measurement data as defined in claim 6 wherein step (c) the location is determined in accordance with $r = \mathrm{mod}(n-1, N)+1$ with r indicating the location within the allocated k-space matrix, and N indicating the total number of rows in the allocated k-space matrix.

8. A method for motion correcting MRI measurement data as defined in claim 7 wherein the parameters P_c and f_s are such that the greatest common divisor of $P_c f_s$ and N is one.

9. A method for motion correcting MRI measurement data as defined in claim 8 wherein N is a radix 2 number and $P_c f_s$ is an odd integer.

10. A method for motion correcting MRI measurement data as defined in claim 9 wherein the steps of (b) and (c) comprise the steps of:

allocating a first set $k_x[1]$ to a 1st k-space matrix as the first row forming a first element (1, 1) of a 2D array having $P_c f_s$ rows and N columns;

continuously filling the elements of the 2D array with subsequent sets by increasing each of row number and column number of the 2D array elements by 1 until all elements of the 2D array are filled;

filling an element in the 1st row of a same column with a subsequent set after filling an element in the $P_c f_s$ th row; and,

filling an element in the 1st column of a same row with a subsequent set after filling an element in the N th column.

11. A method for motion correcting MRI measurement data as defined in claim 2 wherein the motion comprises two periodic motions.

12. A method for motion correcting MRI measurement data as defined in claim 11 wherein the two periodic motions are cardiac motion and respiratory motion.

13. A method for motion correcting MRI measurement data as defined in claim 12 wherein the period P_c is determined in accordance with $P_c = \frac{n}{f_{ecg}} = \frac{m}{f_{breath}}$ with f_{ecg} and f_{breath} being the cardiac and respiratory frequencies, respectively, and m and n are integers.

14. A method for motion correcting MRI measurement data as defined in claim 13 wherein for a given cardiac frequency f_{ecg} the respiratory frequency f_{breath} is determined in accordance with $f_{breath} = \frac{m}{n} f_{ecg}$.

15. A method for motion correcting MRI measurement data as defined in claim 2 comprising the step of: receiving motion data indicative of a motion signal acquired from the object simultaneously with the plurality of sets of MRI measurements.

16. A method for motion correcting MRI measurement data as defined in claim 15 wherein the motion signal is indicative of cardiac and respiratory motion of the object.

17. A method for motion correcting MRI measurement data as defined in claim 16 wherein the motion signal of cardiac motion is an ECG signal.

18. A method for motion correcting MRI measurement data as defined in claim 16 comprising the steps of:
selecting phases of cardiac and respiratory cycles and determining respective ranges based on the motion data; and,

selecting sets of the plurality of sets of the MRI measurement data being acquired during the selected phases of cardiac and respiratory cycles and falling within the ranges.

19. A method for motion correcting MRI measurement data as defined in claim 15 wherein the motion of the object is a rigid body motion and wherein the motion signal is indicative of translational and rotational motion of the object.

20. A method for motion correcting MRI measurement data as defined in claim 19 comprising the steps of:
inverse Fourier transforming the at least a k-space matrix producing at least a reconstructed image portion of the at least an image;
transforming the at least a reconstructed image portion for correcting at least one of translational and rotational motion; and,
superposing the at least a transformed image portion producing the at least an image.

21. A method for motion correcting MRI measurement data as defined in claim 20 comprising the step of processing the at least a transformed image portion to coincide with a grid location of the at least an image.

22. A method according to claim 20 wherein the step of transforming is performed for correcting for both rotational and translational motion.

23. A method for motion correcting MRI measurement data as defined in claim 22 comprising the step of processing the at least a transformed image portion to coincide with a grid location of the at least an image.

24. A method for motion correcting MRI measurement data comprising the steps of:
receiving a plurality of sets of the MRI measurement data indicative of an image of an object, each set corresponding to one row k_x of a k-space matrix;
receiving cardiac and respiratory signal data, the cardiac and respiratory signal data being acquired simultaneously with the MRI measurement data from the object;

selecting phases of cardiac and respiratory cycles and determining respective ranges based on the cardiac and respiratory signal data;
selecting sets of the plurality of sets of the MRI measurement data being acquired during the selected phases of cardiac and respiratory cycles and falling within the determined ranges;
determining for each selected set of the plurality of sets of the MRI measurement data a location within a k-space matrix corresponding to a row of the k-space matrix allocated thereto;
generating the k-space matrix based on the allocated sets; and,
reconstructing an image by inverse Fourier transforming the k-space matrix.

25. A method for motion correcting MRI measurement data as defined in claim 24 comprising the step of selecting a different phase of the cardiac and/or respiratory cycles if the k-space matrix is not filled completely.

26. A method for motion correcting MRI measurement data as defined in claim 24 comprising the step of increasing the ranges of the selected phases if the k-space matrix is not filled completely.

27. A method for motion correcting MRI measurement data as defined in claim 24 comprising the step of filling missing elements of the k-space matrix by interpolating between measurements of adjacent elements.

28. A method for motion correcting MRI measurement data as defined in claim 24 wherein the range of the selected phase of the cardiac cycle is determined along time axis.

29. A method for motion correcting MRI measurement data as defined in claim 27 wherein the range of the selected phase of the respiratory cycle is determined along chest volume axis.

30. A method for motion correcting MRI measurement data as defined in claim 24 wherein the exhale phase of the respiratory cycle is selected.

31. A method for motion correcting MRI measurement data as defined in claim 24 wherein the diastole phase of the cardiac cycle is selected.

32. A method for motion correcting MRI measurement data as defined in claim 30 wherein the diastole phase of the cardiac cycle is selected.

33. A system for motion correcting MRI measurement data comprising a storage medium having stored therein executable commands for execution on a processor, the processor when executing the commands performing the steps of:
receiving a plurality of sets of the MRI measurement data indicative of at least an image of an object, each set corresponding to one row k_x of a k-space matrix of at least a k-space matrix;
receiving motion data indicative of a motion signal acquired from the object simultaneously with the plurality of sets of MRI measurements;
selecting each set of the plurality of sets of the MRI measurements a k-space matrix of the at least a k-space matrix for allocation thereto;
determining for each set of the plurality of sets of the MRI measurement data a location within the k-space matrix allocated thereto; and,
generating at least a k-space matrix based on the sets of the plurality of sets of the MRI measurement data allocated thereto.

34. A system for motion correcting MRI measurement data as defined in claim 33 wherein the storage medium comprises executable commands for execution on a processor, the processor when executing the commands performing the step of determining the k-space matrix of the at least a k-space matrix for selection based on the motion data.

35. A system for motion correcting MRI measurement data as defined in claim 34 comprising:
a first port for receiving the plurality of sets of the MRI measurement data;
a second port for receiving the motion data; and,
a processor in data communication with the first port, the second port and the storage medium, the processor for executing the executable commands for processing the plurality of sets of the MRI measurement data.

36. A system for motion correcting MRI measurement data as defined in claim 35 wherein the storage medium comprises executable commands for execution on the processor, the processor when executing the commands performing the step of: reconstructing at least an image by inverse Fourier transforming the at least a k-space matrix.

37. A system for motion correcting MRI measurement data as defined in claim 36 comprising a display in data communication with the processor for displaying the at least an image.

38. A system for motion correcting MRI measurement data as defined in claim 37 comprising a MRI system for acquiring the plurality of sets of MRI measurements from the object and for providing measurement data indicative thereof, the MRI system for being in data communication with the first port.

39. A system for motion correcting MRI measurement data as defined in claim 38 comprising a motion sensing system for acquiring a motion signal from the object and for providing motion data indicative thereof, the motion sensing system for being in data communication with the second port.

40. A system for motion correcting MRI measurement data as defined in claim 39 comprising:
a first sensor for sensing cardiac motion of the object; and,
a second sensor for sensing respiratory motion of the object.

41. A system for motion correcting MRI measurement data as defined in claim 39 wherein the motion sensing system comprises a sensor for acquiring a motion signal indicative of translational and rotational motion of the object.